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Database Description, Data Summary and Analysis of the Wolverine Harvest from Kugluktuk, Umingmaktok and Bathurst Inlet, Northwest Territories 1985/86-1996/97

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ABSTRACT

This report describes the data standards and data format for harvest information collected from a wolverine harvest in the Central Arctic from 1985-1997. It comments on the intention behind variables selected and provides a brief summary and analysis of some of the data collected. The harvest ranged from the west shore of Great Bear Lake to the east end of Kent peninsula, and to the south end of Contwoyto Lake. Over the eleven years covered by the collection, 822 wolverines were recorded harvested. Eighty-one percent were hunted, while just 18% were trapped. Sex ratio (M:F) of the overall harvest was 1.87, while the sex ration of the trapped animals was close to 1:1. Younger animals made up a significant part of the harvest with the average age of males and females 1.5 and 1.7 years respectively. The maximum age recorded was an 11 year old female. Counts of corpora lutea from adult females resulted in an *in vivo* litter size of 3.46. Some options for indexing harvest intensities are considered.

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INTRODUCTION

Although wolverines (*Gulo gulo*) are often considered as a species of the boreal forest, they also thrive on the barrenlands of northern Canada. Wolverine have been harvested in the Northwest Territories (NWT) for centuries. They are an economically significant wildlife resource and communities representing all regions of the NWT report harvesting the species. Much of the ecology of wolverines and the extent and composition of the harvest is not known in the NWT. Because most pelts are used domestically or sold locally, the actual harvest is difficult determine.

In late 1985, the regional biologist in Kitikmeot initiated a program to collect the carcasses of wolverines that hunters from the communities of Kugluktuk (Coppermine), Bathurst Inlet and Umingmaktok (Bay Chimo) harvested. This program continued from 1985 through to 1997, with a brief break between 1990 and 1992. As well as providing minimum harvest estimates, examination of carcasses of harvested furbearers can also provide insight into the ecology of a species (Rausch and Pearson 1972). The wolverine carcasses were processed and a variety of measurements and information gathered. A computer database was created to store and provide access to this information. The form of the collection and the type of data collected was an evolutionary process with techniques and measurements changing over the years. Consequently, the database also often changed form from year to year.

The purpose of this current project and report is to provide:

1. Database standardization:

- Design a single standardized version of the harvest database that is common to all years of the harvest collection from 1985/86-1996/97 inclusive;
- Describe the database and provide a rationale for each variable where appropriate; and,
- Proof data for consistency and accuracy.

and

2. Data summaries and analysis:

- Illustrate the spatial pattern of harvest locations for all years combined;
- Summarize the age and sex composition of the harvest; and,
- Describe the reproductive characteristics of the harvested female wolverines.

DATABASE STANDARDIZATION

Methods

Harvest collection

During the period of the harvest collection, the Government of Northwest Territories (GNWT) Department of Renewable Resources (DRR)[1] licence year ran from 1 July - 30 June. The harvest is summarized in this paper such that 88 refers to the 1987-88 hunting season, etc.

In December 1985, hunters and trappers from Umingmaktok, Bathurst Inlet, and Kugluktuk were asked to contribute carcasses from the wolverines they killed. Hunters provided basic information about their harvest. To encourage participation, hunters were paid $15 per carcass from 1985-1990 and $25 per carcass from 1992-1997. Twenty five dollars was a small proportion of the $300-400 the wolverine pelt would bring the hunter and was not considered an incentive to harvest more animals than he would otherwise. If a hunter reported killing a wolverine but did not retain the carcass, as much information was collected as possible and a record added to the database.

Carcass processing

The continuity of data collection can be divided into two time periods. Anne Gunn (Kitikmeot Regional Biologist) processed carcasses from 1985/86-1991/92 and John Lee (Wildlife Biologist, Yellowknife) from 1992/93-1996/97. Carcasses were stored frozen and later thawed for processing. Carcass measurements (Table 1) consisted of body length, chest girth, condyle-basal length, zygomatic width, femur length, and skull profile. The weight of the carcass as received was determined by weighing the carcass to the nearest 0.1 kg with a spring scale and adding 100 g for each missing foot, where required. The weight of the stomach contents was subtracted from the carcass weight to produce an estimated carcass weight. Effects of blood loss and dehydration were ignored. A sample size of 21 wolverines were weighed before and after skinning and the ratio of hide weight to carcass weight was used to estimate a live body weight.

[1]Now the Department of Environment and Natural Resources.

Table 1. Structure of the wolverine harvest database WVK86-97.DBF. Width of numeric variables is designated by the total field width and the number of decimal places, e.g. 4.1 represents a value four spaces wide with one place after the decimal such as 13.2 kg for carcass weight.

	Field Name	Type/Width	Description
1	**SPECNUM**	Character 7	Unique specimen identifier composed of the hunter's town, the number from the tag attached to the carcass, and the season of the harvest. For example: CP14596 indicates a wolverine carcass from Kugluktuk ('CP'), number 145, from the 96 season. 'BC' indicates Umingmaktok; 'BI' indicates Bathurst Inlet.
2	**KILLDATE**	Character 7	The date the wolverine was killed entered in the format DDMMMYY, for example, 12NOV97. Missing values = 'U'.
3	**SEX**	Character 1	Sex of the carcass as processed. Missing values = 'U'.
4	**AGE1**	Numeric 2.0	Age of the wolverine in whole years. Missing values = 99.
5	**ACLASS**	Character 1	Age class of the wolverine. Four possible values. 'J'=juvenile, <1 year, i.e. an animal in its first year. 'Y'=yearling, >1 but <2 an animal in its second year. 'A'=adult, >2 years. Missing value = 'U'.
6	**AQUAL**	Character 3	Age qualifier. Method by which the age was determined. Seven possible values. CEM=cementum ageing of a lower canine, CAN=cementum ageing of a canine, PM1=cementum ageing of a first premolar, PM2=cementum ageing of a second premolar, PUL=pulp cavity measurement, EST=estimated age based on appearance of teeth and carcass. Missing values = 'U'.
7	**KILLMETH**	Character 4	Method by which the wolverine was killed. Six possible values. 'T-QK'=quick kill trap including deadfalls or neck snare. 'O-QK'=other methods of quick kill including running over with snow machine, clubbing, etc. 'T-LH'=leg hold trap or snare, where the animal is not killed quickly. 'T-UN'=wolverine is trapped but method is unknown. SHOT=free ranging wolverine is shot. Missing values = 'U'.
8	**TOWN**	Character 12	Town of hunter. Missing values = 'U'.
9	**LAT**	Numeric 4.0	Latitude of kill location in degrees and minutes. Missing values = 0.

	Field Name	Type/Width	Description
10	**LONG**	Numeric 5.0	Longitude of kill location in degrees and minutes. Missing values = 0.
11	**FNAME**	Character 10	Hunter's first name. Missing values = 'U'.
12	**LNAME**	Character 15	Hunter's last name. Missing values = 'U'.
13	**LOCATION**	Character 22	Description of kill location. Missing values = 'U'.
14	**COMMENT**	Character 60	General comments and comments on teeth and reproduction (e.g. fetus measurements) when sufficient room is not available in those field categories. Missing values = 'U'.
15	**BODYLEN**	Numeric 3.0	Length of the carcass measured in mm along the body contours from tip of the nose to base of the tail. Missing values = 999.
16	**GIRTH**	Numeric 3.0	Chest girth of the carcass measured in mm just posterior to the forelimbs. Missing values are recorded as 999.
17	**CARCWT**	Numeric 4.1	Weight of the carcass as received measured to the nearest 0.1 kg., 100 gm is added to the weight for each missing foot. Missing values = 99.9.
18	**SCWT**	Numeric 4.0	Weight of the stomach contents measured in grams. Missing values = 9999.
19	**ECWT**	Numeric 4.1	Estimated carcass weight. Calculated by subtracting the SCWT from the CARCWT. Missing values = 99.9.
20	**ELBW**	Numeric 4.1	Estimated live body weight. Calculated by multiplying the ECWT by 1.17 for females, 1.21 for males to adjust for hide weight. Missing values = 99.9.
21	**ZYGOMATC**	Numeric 5.1	Width of the skull measured to the nearest 0.1 mm across the widest part of the zygomatic arches. Missing values = 999.9.
22	**CONDOB**	Numeric 5.1	Condylobasal length of the skull measured to the nearest 0.1 mm. Missing values = 999.9.
23	**SPROFILE**	Numeric 5.1	Length of the skull as expressed by the skull profile measured to the nearest 0.1 mm. Missing values = 999.9.

	Field Name	Type/Width	Description
24	**FEMURLEN**	Numeric 3.0	Length of the femur at its longest point measured to the nearest mm. Missing values = 999.
25	**CANINEOK**	Character 1	Are any of the canines broken, chipped, or excessively worn. 'Y' or 'N'. Missing values = 'U'.
26	**INCISSOROK**	Character 1	Are any of the incisors broken, chipped, or excessively worn. 'Y' or 'N'. Missing values = 'U'.
27	**PREMOLAROK**	Character 1	Are any of the premolars broken, chipped, or excessively worn. 'Y' or 'N'. Missing values = 'U'.
28	**MOLAROK**	Character 1	Are any of the molars broken, chipped, or excessively worn. 'Y' or 'N'. Missing values = 'U'.
29	**TETHCOND**	Character 50	Comments on tooth condition.
30	**BACKFAT**	Numeric 2.0	Depth of back fat measured to the nearest mm. Missing values = 99.
31	**INGINFAT**	Numeric 2.0	Depth of inguinal fat measured to the nearest mm. Missing values = 99.
32	**STERNFAT**	Numeric 4.1	Weight of sternal fat measured to the nearest 0.1gm. Missing values = 99.9.
33	**OMENFAT**	Numeric 3.0	Weight of omental fat measured to the nearest gm. Missing values = 999.
34	**LKWT**	Numeric 4.1	Weight of left kidney measured to the nearest 0.1gm. Missing values = 99.9.
35	**RKWT**	Numeric 4.1	Weight of right kidney measured to the nearest 0.1gm. Missing values = 99.9.
36	**LFWT**	Numeric 4.1	Weight of perirenal membrane and attached fat from the left kidney measured to the nearest 0.1 gm. Missing values = 99.9.
37	**RFWT**	Numeric 4.1	Weight of perirenal membrane and attached fat from the right kidney measured to the nearest 0.1gm. Missing values = 99.9.
38	**S_EMPTY**	Character 1	Is the stomach empty, 'Y' or 'N'. Missing values = 'U'.

	Field Name	Type/Width	Description
39	**CARIBOU**	Character 1	Was caribou present, 'Y' or 'N'. Missing values = 'U'.
40	**MUSKOX**	Character 1	Was muskox present, 'Y' or 'N'. Missing values = 'U'.
41	**MICE**	Character 1	Were microtines present, 'Y' or 'N'. Missing values = 'U'.
42	**PTARMIGN**	Character 1	Was ptarmigan present, 'Y' or 'N'. Missing values = 'U'.
43	**HARE**	Character 1	Was hare present, 'Y' or 'N'. Missing values = 'U'.
44	**SEAL**	Character 1	Was seal present, 'Y' or 'N'. Missing values = 'U'.
45	**WOLVERIN**	Character 1	Was wolverine present, 'Y' or 'N'. Missing values = 'U'.
46	**SICSIC**	Character 1	Was Arctic ground squirrel present, 'Y' or 'N'. Missing values = 'U'.
47	**VEG**	Character 1	Was vegetation present, 'Y' or 'N'. Missing values = 'U'.
48	**FISH**	Character 1	Was fish present, 'Y' or 'N'. Missing values = 'U'.
49	**OTHER**	Character 10	Other items present in the stomach.
50	**MEAT**	Character 1	Was meat present, 'Y' or 'N'. Missing values = 'U'.
51	**BONE**	Character 1	Was bone present, 'Y' or 'N'. Missing values = 'U'.
52	**HAIR**	Character 1	Was hair or fur present, 'Y' or 'N'. Missing values = 'U'.
53	**CORP**	Numeric 2.0	The number of corpora lutea in sectioned ovaries. Missing values = 99.
54	**FETUS**	Numeric 1.0	The number of fetuses or obvious implantation sites visible while doing dissections. Missing values = 9.
55	**REPROCOM**	Character 25	Comments related to reproductive organs and fetus measurements. These also can occur in the COMMENT field. Fetus measurements are expressed as: F1 (fetus1) = crown/rump length of fetus in mm, sex of fetus, weight of fetus in gm; F2 = etc. For example, F1 = 86, M, 27.
56	**BACULLEN**	Numeric 4.1	Length of clean dried baculum to the nearest 0.1 mm. Missing values = 99.9.
57	**BACULWT**	Numeric 3.1	Weight of clean dried baculum to the nearest 0.1 gm. Missing values = 9.9.

	Field Name	Type/Width	Description
58	**ALONE**	Character 1	Was the wolverine on its own when killed, 'Y' or 'N'. Missing values = 'U'.
59	**SEA**	Numeric 2.0	The season of the harvest expressed as the year in which it ended, e.g. The 1992/93 season would be recorded as 93. Missing values = 0.
60	**KDATE**	Numeric 8.0	Date killed, entered in the date format mm/dd/yy, e.g. 02/12/97 representing February 12, 1997. Missing values not recorded.
61	**MON**	Numeric 2.0	Month of the year in which the wolverine was killed. Missing values = 99.

An array of skull and tooth measurements based on Banci (1982), was also collected (Table 2). Flesh was removed from skulls by slow cooking for several hours until it could be pulled off. Skulls were then air dried before measurements were taken. Percent of internasal and zygomatic suture closure was estimated by inspection (by Anne Gunn) before drying. The distance between the alveolus and the enamel line was measured for the maxillary and mandibular canines. The canine length and diameter were also measured. Skull and tooth measurements, other than condylobasal length, zygomatic breadth and skull profile, were not collected after the 1989/90 season.

Each kidney with its attached perirenal membrane and fat was removed from the body cavity. The perirenal membrane and fat were detached from the kidney and weighed as a unit. The kidney was also weighed. Sternal fat, the discrete fat deposit attached along the centre line of the inside ventral abdominal wall extending from the diaphragm to the pelvis was removed and weighed. The omental fat and attached membranes were carefully separated from the internal organs and weighed. The depth of back fat was measured *in situ* by making an incision along a line 45° from the base of the tail toward the upper end of the femur and measuring the greatest fat depth. Inguinal fat, the external fat deposit in the groin area, was measured by making an incision through the fat at right angles to the longitudinal body axis and measuring the greatest fat depth. The sternal, omental, and perirenal fat deposits could be used to produce a body fat index to reduce bias from carcass weights: fat index = (sternal fat weight + omental fat weight + perirenal fat weight)/carcass weight. A kidney fat index was also possible (perirenal fat weight/kidney weight).

Table 2. Structure of the wolverine skull database, WVSKULL.DBF. The skull and tooth measurements listed below are described in Banci (1982). Width of numeric variables is designated by the total width and the number of decimal places, e.g. 4.1 represents a value four spaces wide (including the decimal) with one place after the decimal such as 13.2 kg for carcass weight.

	Field	Type/Width	Description
1	**SPECNUM**	Character 7	Unique specimen identifier identical to that in WVK86-97.DBF (Table 1).
2	**KDATE**	Date 8	Kill date in date format.
3	**SEX**	Character 1	Sex of wolverine. Missing values = 'U'.
4	**AGE1**	Numeric 2.0	Age of wolverine. Missing values = 99.
5	**SKULLDAM**	Character 10	Comments on the condition of the skull.
6	**INTERORB**	Numeric 5.1	Interorbital breadth measured to the nearest 0.1mm. Missing values = 999.9.
7	**ECTOORB**	Numeric 5.1	Ectoorbital breadth measured to the nearest 0.1mm. Missing values = 999.9.
8	**FORAMEN**	Numeric 5.1	Foramen magnum length measured to the nearest 0.1mm. Missing values = 999.9.
9	**SKULL**	Numeric 5.1	Skull length measured to the nearest 0.1mm. Missing values = 999.9. Skull length (SKULL) (Banci 1982) and skull profile (SPROFILE in Table 1) (Wiig 1989) appear to measure the same length and should represent the same measurement. However, when examined, they do not have similar values. SPROFILE was significantly larger than SKULL in both sexes ($t=10.29$, $p<0.001$, $df=158$). SKULL was measured with Vernier calipers and SPROFILE with digital calipers.
10	**SAGGITAL**	Numeric 5.1	Length of the sagittal crest extension calculated by subtracting CONDOB from SKULL and collected with the intent to estimate age classes. Missing values = 999.9.
11	**SUTRINTER**	Numeric 3.0	Percent closure of the internasal suture as estimated on a de-fleshed skull. These measurements were used to estimate age of wolverines. Results are presented in Poole et al. (1994). Missing values = 999.
12	**SUTRSZYGO**	Numeric 3.0	Percent closure of the zygomatic suture as estimated on a de-fleshed skull. These measurements were used to estimate age

	Field	Type/Width	Description
			of wolverines. Results are presented in Poole et al. (1994). Missing values = 999.
13	**CMAXL1**	Numeric 5.2	Length of one maxillary canine tooth measured to the nearest 0.01mm. Missing values = 99.99.
14	**CMAXL2**	Numeric 5.2	Length of the other maxillary canine tooth measured to the nearest 0.01mm. Missing values = 99.99.
15	**CMAXL3**	Numeric 5.2	Mean length of the maxillary canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. Missing values = 99.99.
16	**CMAXD1**	Numeric 5.2	Diameter of one maxillary canine tooth measured to the nearest 0.01mm. Missing values = 99.99.
17	**CMAXD2**	Numeric 5.2	Diameter of the other maxillary canine tooth measured to the nearest 0.01mm. Missing values = 99.99.
18	**CMAXD3**	Numeric 5.2	Mean diameter of maxillary canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. Missing values = 99.99.
19	**CMAXE1**	Numeric 4.2	The distance between the alveolus and the enamel line of one maxillary canine tooth measured to the nearest 0.01 mm. Missing values = 9.99.
20	**CMAXE2**	Numeric 4.2	The distance between the alveolus and the enamel line of the other maxillary canine tooth measured to the nearest 0.01 mm. Missing values = 9.99.
21	**CMAXE3**	Numeric 4.2	Mean distance between the alveolus and the enamel line of the maxillary canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. This measurement was intended as an ageing tool, utilizing the enamel line technique (Churcher 1960). Missing values = 9.99.
22	**CMADL1**	Numeric 5.2	Length of one mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 99.99.
23	**CMADL2**	Numeric 5.2	Length of the other mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 99.99.

	Field	Type/Width	Description
24	**CMADL3**	Numeric 5.2	Mean length of the mandibular canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. Missing values = 99.99.
25	**CMADD1**	Numeric 5.2	Diameter of one mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 99.99.
26	**CMADD2**	Numeric 5.2	Diameter of the other mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 99.99.
27	**CMADD3**	Numeric 5.2	Mean diameter of mandibular canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. Missing values = 99.99.
28	**CMADE1**	Numeric 4.2	The distance between the alveolus and the enamel line of one mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 9.99.
29	**CMADE2**	Numeric 4.2	The distance between the alveolus and the enamel line of the other mandibular canine tooth measured to the nearest 0.01 mm. Missing values = 9.99.
30	**CMADE3**	Numeric 4.2	Mean distance between the alveolus and the enamel line of the mandibular canine teeth calculated from the above two measurements. Where only one measurement was available, that value was entered here. This measurement was intended as an ageing tool, utilizing the enamel line technique (Churcher 1960). Missing values = 9.99.
31	**P4WIDTH**	Numeric 5.2	Width of the fourth premolar measured to the nearest 0.01 mm. Missing values = 99.99.
32	**P4LEN**	Numeric 5.2	Length of the fourth premolar measured to the nearest 0.01 mm. Missing values = 99.99.
33	**M1LEN**	Numeric 5.2	Length of the first molar measured to the nearest 0.01 mm. Missing values = 99.99.

Flesh was removed from the baculums and they were oven dried at (5° C) for two days before being weighed and measured. The female reproductive system was dissected out. Fetuses were freed from the placenta and surrounding tissue before being weighed and the crown-rump length measured (Table 3). Where fetuses were too small to measure, a value of 1.0 was used in the

database to distinguish those entries from missing values. Ovaries were stored in 10% formalin and later cut longitudinally into 1-2 mm slices to count corpora lutea. Placental scars were not recorded. Females with corpora lutea, fetuses, or implantation sites present were considered pregnant (Banci and Harestad 1988, Mead et al. 1991). Stomach contents were examined by washing them over a sieve and identifying bones, fur, feathers, and other ingesta.

Table 3. Structure of the wolverine fetus database MAC-PREG.DBF.

	Field Name	Type/Width	Description
1	**SPECNUM**	Character 7	Specimen identifier identical to WVK86-97.DBF (Table 1).
2	**AGE1**	Numeric 2	Age of wolverine. Identical to WVK86-97.DBF
3	**KDATE**	Date 8	Kill date in date format. Identical to WVK86-97.DBF
4	**F1LEN**	Numeric 5.1	Crown-rump length of first fetus. Missing value = 999.9. Unmeasurable=1.0
5	**F2LEN**	Numeric 5.1	Crown-rump length of second fetus. Missing value = 999.9. Unmeasurable=1.0
6	**F3LEN**	Numeric 5.1	Crown-rump length of third fetus. Missing value = 999.9. Unmeasurable=1.0
7	**F4LEN**	Numeric 5.1	Crown-rump length of fourth fetus. Missing value = 999.9. Unmeasurable=1.0
8	**F5LEN**	Numeric 5.1	Crown-rump length of fifth fetus. Missing value = 999.9. Unmeasurable=1.0
9	**SEX1**	Character 1	Sex of first fetus. Missing value = 'U'.
10	**SEX2**	Character 1	Sex of second fetus. Missing value = 'U'.
11	**SEX3**	Character 1	Sex of third fetus. Missing value = 'U'.
12	**SEX4**	Character 1	Sex of fourth fetus. Missing value = 'U'.
13	**SEX5**	Character 1	Sex of fifth fetus. Missing value = 'U'.

	Field Name	Type/Width	Description
14	F1WT	Numeric 5.1	Weight of first fetus. Missing value = 999.9. Unmeasurable = 1.0.
15	F2WT	Numeric 5.1	Weight of second fetus. Missing value = 999.9. Unmeasurable = 1.0.
16	F3WT	Numeric 5.1	Weight of third fetus. Missing value = 999.9. Unmeasurable = 1.0.
17	F4WT	Numeric 5.1	Weight of fourth fetus. Missing value = 999.9. Unmeasurable = 1.0.
18	F5WT	Numeric 5.1	Weight of fifth fetus. Missing value = 999.9. Unmeasurable = 1.0.

Age was determined by cementum aging of a lower canine. The ratio of canine pulp cavity width to tooth width (Poole et al. 1994) was at times used to age animals in their first year. Wolverines in their first year (<1) were classified as juveniles, as yearlings in their second, and as adults if they were two years or older.

Database Descriptions

Measurements taken from the carcasses were organized into a database, WVK86-97.DBF, in Dbase3+ and imported into a Microsoft Access table, WVK86-97. This database consists of 61 fields comprising 347 characters per record. In Table 1, the fields appear in the order in which they occur in the database and are organized in 8 general categories:

1. Basic specimen information, fields 1-7.
2. Hunter and location information, fields 8-14.
3. Soft body measurements, fields 15-20.
4. Hard body measurements, fields 21-29.
5. Fat measurements, fields 30-37.
6. Stomach contents, fields 38-52.
7. Reproductive data, fields 53-57.
8. Miscellaneous data, fields 58-61.

Skull and tooth measurements were organized into a second database in Dbase3+, WVSKULL.DBF, and imported into a Microsoft Access table, WVSKULL. This database consists of 33 fields comprising 159 characters per record. In Table 2, the fields appear in the order in which they occur in the database. The most frequently taken skull measurements: condylobasal length, zygomatic breadth, and skull profile are not included in this database but appear in the more general one, WVK86-97.DBF.

Reproductive information relating to fetus measurements were organized into a third database in Dbase3+, MAC-PREG.DBF, and imported into a Microsoft Access table, MAC-PREG. This database consists of 18 fields comprising 78 characters per record (Table 3).

Within Microsoft Access, Dbase3+ databases become tables of a larger database. The three Microsoft Access tables above, WVK86-97, WVSKULL, and MAC-PREG are all tables within the larger Microsoft Access database, WOLVERINE.MDB. Four fields, SPECNUM, AGE1, SEX, and KDATE are common to all three tables. SPECNUM is a unique specimen identifier and could be used as a primary key to link the tables in Microsoft Access.

Detail of fields appearing in wolverine carcass database WVK86-97.DBF

SPECNUM

This is a seven place character variable uniquely identifying the wolverine specimen. It contains three pieces of information. The first two characters designate the hunter's town. 'CP'=Coppermine (Kugluktuk), 'BC'=Bay Chimo (Umingmaktok), and 'BI'=Bathurst Inlet. The next three characters are the actual number from carcass tags distributed to the communities. The final two characters represent the hunting season. In some instances, an animal was killed but no carcass was turned in and consequently no carcass tag (with number) was issued. In such cases the wolverines are assigned an arbitrarily chosen consecutive "star" number and the SPECNUM contains a '*', e.g. 'CP*1695'.

KILLDATE

This is a seven place character variable containing the date the animal was harvested. The format is day month year (e.g. '12NOV95') and was chosen to eliminate errors that can easily be made while entering dates as numbers only. In cases where the month and year were known but the day was not, the day was entered as '00' or '01'. The disadvantage of using a character format for date is that it complicates analysis using date as a variable. To address this, fields called KDATE, MON, and SEA have been included at the end of the database. KDATE is the KILLDATE in a Dbase3+ date format which can be manipulated, MON is the numeric value of the month, and SEA is the hunting season.

SEX

Sex of the carcass as processed.

AGE1

Age of the wolverine in full years. Because the harvest season runs to April, we consider a wolverine born in February 1995 and killed in April 1996 to be 0 years, i.e. as an animal in its first winter. It would be aged as 1 in April 1997.

ACLASS

This field is derived from AGE1. An animal aged 0 is classed as a juvenile, animal one year old are classed as yearlings, and those two and over are considered adults. There is some evidence (Blomqvist 1995, Copeland 1996) that at least for males, it might make sense to redefine these categories such that animals one and two are subadults and those wolverines three years and older as adults.

AQUAL

This is an age qualifier to indicate how the age was determined. The current standard is to obtain a cementum age from a canine, as other teeth proved less consistent (Poole et al. 1994). In the early years, during the process of exploring which tooth would be most reliable, ages were obtained from several tooth types, hence the need to differentiate with 'CAN', 'PM1', and 'PM2' values for AQUAL. A 'PUL' designation refers to an age determined by the pulp cavity width to canine width ratio (Poole et al. 1994). This method can effectively age juveniles and save some processing cost at an ageing lab, however, preparation time and measurements after x-rays requires several man hours.

KILLMETH

Kill methods are organized into two broad categories, trapped and hunted. In trapping the harvest device remains stationary and the wolverine must come to it. Hunting implies neither the harvest device nor the animal is stationary and harvest occurs either opportunistically or from seeking out the wolverine. There is likely vulnerability bias in the sample that each method would produce. Trapping can further be broken down into quick killing and holding devices. Wolverines caught in holding devices tend to lose much of their body fat as well as some muscle mass. Analysis of related parameters could be affected.

TOWN

Three towns, Kugluktuk, Umingmaktok, and Bathurst Inlet (entered in the database as Coppermine, Bay Chimo, and Bathurst) were directly involved with the carcass collection. Some hunters from Cambridge took wolverines in the Umingmaktok/Bathurst Inlet area and are consequently included in this database. In these instances, the hunter's town remained as Cambridge, but the town identifier in SPECNUM was set to 'BC'. Because the carcasses from both Umingmaktok and Bathurst Inlet are collected and tagged in Umingmaktok, and because some of the hunters change their place of residence, it is often difficult to determine which of these towns accounted for the kill. Other than book keeping, it's probably not critical to know more than the harvest was from the Bathurst Inlet area.

LAT and LONG

Coordinates of the harvest location. These are primarily estimates from the hunters and in most cases cannot be considered exact.

LOCATION

A description of where the kill occurred. This can be used to establish a LAT and LONG when none is given.

BODYLEN

Length of the body measured along its contours from the tip of the nose to the base of the tail. It may be a measurement that could be dropped from the processing as many years of this measurement have been collected and its continued utility is questionable.

GIRTH

Heart girth measured just behind the forelimbs. Subcutaneous fat deposits tend to be located posteriorly on wolverines and the girth would not vary much with increased fat deposition.

Carcasses can deform by being piled or bent while freezing. This has the potential to affect the girth measurements. Similarly to BODYLEN, this may be a measurement that could be dropped from the processing.

CARCWT

Weight of the carcass as received. This measurement would not account for weight loss by dehydration or blood loss, but it does include the weight of the stomach contents. If feet are missing, an estimate of 100 gm for each foot is added immediately to the recorded value of CARCWT.

SCWT

Weight of the stomach contents. This measure is taken so that it can be subtracted from the CARCWT to help standardize it.

ECWT

Estimated carcass weight. Subtracting the weight of the stomach contents (SCWT) from the carcass weight (CARCWT) creates this variable. Some wolverines are killed with over 1 kg of food in their stomachs and some have empty stomachs. The creation of ECWT is an attempt to standardize the measure of carcass weight.

ELBW

Estimated live body weight. A sample of wolverines was weighed before and after skinning and the ratio of hide weight to carcass weight was calculated. This ratio was 0.17 for females (n=6) and 0.21 (n=15) for males. ELBW is simply the estimated carcass weight (ECWT) increased by the appropriate proportion to produce an estimate of live body weight by including the hide weight.

ZYGOMATC, CONDOB, and SPROFILE

Standard skull measurements: zygomatic width, condylobasal length, and skull profile measured with callipers to the nearest 0.1 mm. The condylobasal measurement has potential to differentiate males and females of ages greater than nine months (Magoun 1985, Wiig 1989). Measurements made prior to 1991/92 were made on air-dried, cleaned skulls; after 1992 measurements were made *in situ* on fresh, defrosted carcasses. Collecting skull profile measurements began in the 1995/96 season as a hard body measurement that best reflected the overall size of wolverine skulls (Wiig 1989). See Wiig (1989) for skull measurements. Also see SKULL in Table 2.

FEMURLEN

Length of the femur measured *in situ* at its longest part. This measurement was collected in an attempt to find a hard body measurement that reflected general body size to use to standardize a body fat index.

CANINEOK, INCISSOROK, PREMOLAROK, MOLAROK, and TETHCOND

Yes/no variables that flag tooth condition. Poor tooth condition may represent a serious problem for a predator and have a direct effect on its survival. The intention of collecting this measurement was to eventually examine tooth breakage similar to Van Valkenburgh (1988) and Vila (1993).

BACKFAT

The measurement of the back fat is described above in Methods. The measurement problems associated with inguinal fat (below) are also common to back fat measurements.

INGINFAT

Inguinal fat is the fat deposit in the groin area. The recording of this variable was discontinued in the 1994/95 season, as it was somewhat subjective depending on where the incision was made. Fat was also removed during skinning and there was no way to account for this.

STERNFAT

Sternal fat is a discrete fat deposit attached along the centre line of the inside ventral abdominal wall extending from the diaphragm to the pelvis. This depot is easily identified, its limits clear, and it is easily removed.

OMENFAT

Recording of omental fat began in the 1995/96 season. This depot has shown potential to be a predictor of total body fat content (Buskirk and Harlow 1989).

LKWT and RKWT

Weight of left and right kidney with perirenal membranes and fat removed.

LFWT and RFWT

Weight of the perirenal membrane with attached fat from the left and right kidney. Collection of kidney fat weights and kidney weights were intended for use in the calculation of a kidney fat index.

S_EMPTY

A yes/no variable to flag whether the stomach was empty.

CARIBOU, MUSKOX, MICE, PTARMIGN, HARE, SEAL, WOLVERIN, SICSIC, VEG, FISH

The preceding are yes/no variables indicating the presence or absence of a food type in the stomach. There may be several items in a single stomach. The presence of vegetation may be an indicator of consumption of a cached item.

OTHER

Items which occur in the stomach other than those listed above.

MEAT, BONE, HAIR

These three fields are yes/no variables intended to indicate an approximate composition of the stomach contents.

CORP

This is the number of corpora lutea recorded during sectioning of the ovaries. Because wolverines are induced ovulators, animals with corpora lutea present have bred and could be considered pregnant.

FETUS

This is the number of fetuses present during dissection. A small number of females processed each year have observable fetuses or identifiable implantation sites (swellings) in the uterus. The crown/rump length of the fetus is measured in mm, the sex recorded, and the fetus weighed in gm. The size can range from 127 mm to un-measurable implantation sites. This information is recorded in the REPROCOM or the COMMENT field in the format: F1=126, M, 133. It is also recorded in the database MAC-PREG.DBF (Table 3).

REPROCOM

This field contains comments related to the reproductive data.

BACULLEN

Length of the clean and dried baculum. This measurement was not continued after the 1989/90 season.

BACULWT

Weight of the clean and dried baculum. This measurement was not continued after the 1989/90 season.

ALONE

This is a yes/no variable that flags whether an animal was alone when it was killed. This would apply primarily to animals tracked by snow machine and shot. This item was added to the Carcass Collection Form as a space to be completed in 1993/94 season. Information collected prior to 1993/94 was offered unprompted by the hunter. The intention of collecting this information was to gain an indication of when animals were occurring in groups. From this, some understanding might be gained about how long young animals remain with their mother, or together as siblings. Archived tooth samples from animals travelling together when killed could provide family relationships through DNA analysis. Future collections should include muscle samples for DNA analysis from wolverines known to be travelling together. This could complement the ecological study done at Daring Lake (Mulders et al. 2007).

SEA

This is the hunting season in which the wolverine was killed. This variable is useful in grouping hunting records. For example, 93 would indicate the 1992/93 harvest season.

KDATE

The date the wolverine was reported killed. This variable is in 'date' field format that facilitates sorting and data analysis.

MON

A numeric record of the month of the year in which the wolverine was killed. This variable facilitates sorting and data analysis.

DATA SUMMARIES AND ANALYSIS

Methods

The consistency of the harvest collection effort varied over the 12 year period. There was no quantifiable measure of the degree of completeness of the collection in each season. However, I was able to compare the wolverine harvest estimated by three independent methods:

- DRR fur harvest statistics where pelts are processed through DRR and sent to fur auctions;
- Kitikmeot Wildlife Harvest Study (KWHS) a cooperative effort between the Kitikmeot Hunters and Trappers Association and the DRR (Jingfors 1984, D'hont and Croft 1995); and,
- Wolverine carcass collection.

The fur harvest statistics consistently under-represented both the harvest estimated by the carcass collection and by the KWHS during the three seasons the methods overlapped (Table 4).

Table 4. Wolverine harvest estimates for Kugluktuk, Umingmaktok and Bathurst Inlet from 1982/83-1996/97 derived by three different techniques. Shade area is seasons of overlap.

Hunting Season	Kitikmeot Harvest Study	Carcass Collection	Fur Statistics
1982/83	63	**	**
1983/84	84	**	**
1984/85	69	**	**
1985/86	65	33	**
1986/87	115	103	73
1987/88	76	65	38
1988/89	92	45	25
1989/90	**	34	20
1990/91	**	**	15
1991/92	**	50	44
1992/93	**	94	24
1993/94	**	82	19

Hunting Season	Kitikmeot Harvest Study	Carcass Collection	Fur Statistics
1994/95	**	94	**
1995/96	**	85	**
1996/97	**	137	**

The carcass collection and the KWHS reflected similar harvest levels in 1987 and 1988, but diverged considerably in 1989. The annual average of 80.6 (n=7) wolverines reported by the KWHS over seven seasons is similar to annual totals from the carcass collection during 1987 and 1988, and the 1993 to 1997 period when efforts were made to account for the total harvest.

The collection program in the Kitikmeot was not active during the 1991 season. The 1986, 1989, 1990, and 1992 seasons were not included in comparisons of age between months within a hunting season or between months among hunting seasons (Table 5). Similarly, 1985/86 and 1989/90 were not included in comparisons of sex distribution between months within a hunting season, or between months among hunting seasons. Comparisons of age and sex distribution between months when seasons were lumped include all hunting seasons.

Table 5. Comments on the completeness of the wolverine carcass collection.

Season	Comments	
1985/86	Incomplete collection for first half of hunting season	May bias comparisons of sex or age by month or hunting season
1986/87	Effort to collect complete harvest	Reflective of KWHS numbers
1987/88	Consistent with 86/87	Reflective of KWHS numbers
1988/89	Ages missing from a large set of samples[1]. Some question of completeness (Table 4).	May bias comparisons of age by month or hunting season
1989/90	Incomplete collection for last half of hunting season	May bias comparisons of sex or age by month or hunting season
1990/91	No collection	
1991/92	Intermittent collection	May bias comparisons of sex or age by month or hunting season
1992/93	Renewed effort to collect complete harvest	Reflective of KWHS numbers

Season	Comments	
1993/94	Consistent with 92/93	Reflective of KWHS numbers
1994/95	Consistent with 93/94	Reflective of KWHS numbers
1995/96	Consistent with 94/95	Reflective of KWHS numbers
1996/97	Consistent with 95/96	Reflective of KWHS numbers

[1]In the 1988/89 season, labels from 33 out of 45 skulls were lost and no ages were determined.

For comparisons among seasons of the year, the hunting period was divided into three intervals based on photoperiod and minimum temperature. October and November constituted the fall with decreasing light and falling temperature; December, January and February (Dec-Feb), the colder, dark winter period; and March and April the spring with increasing photoperiod and adult females occupied with young. For some analysis wolverines were divided into six sex/age classes as follows: juvenile, yearling, and adult males (JM, YM, AM) and juvenile, yearling, adult females (JF, YF, AF). Animals that were taken by methods other than traps are referred to as harvested by hunting; those taken by traps are referred to as harvested by trapping.

Statistical differences in distributions were examined with chi-square and difference in means with analysis of variance and Student's t-test. Significance was considered to be at the 0.05 probability level. Harvest locations plots were prepared with Tydac Research Inc. Spans Explorer version 7.0.

RESULTS

Annual Harvest

Harvest numbers

A total of 822 wolverines were reported killed over the period December 1985 - April 1997 (Table 6). Missing data for various summaries and analysis reduced this sample. Where the method of harvest was known, 81% of the wolverines were shot, 18% were trapped and 1% was killed by other methods. Of the trapped animals (n=147), 30% were taken in leg hold traps, 67% in quick kill traps, and 3% were trapped by unknown means. By including the harvest estimates provided by the KWHS, a longer term picture of the wolverine harvest was possible (Figure 1).

Table 6. Number of wolverines harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86 - 1996/97.

	Harvest Season											
Town	**86**	**87**	**88**	**89**	**90**	**92**	**93**	**94**	**95**	**96**	**97**	**Total**
Kugluktuk	27	79	43	38	27	50	63	53	73	64	105	622
Umingmaktok	6	24	17	6	7	0	25	24	12	16	23	160
Bathurst Inlet	0	0	5	0	0	0	5	5	9	5	9	38
Cambridge	0	0	0	1	0	0	1	0	0	0	0	2
Total	33	103	65	45	34	50	94	82	94	85	137	822

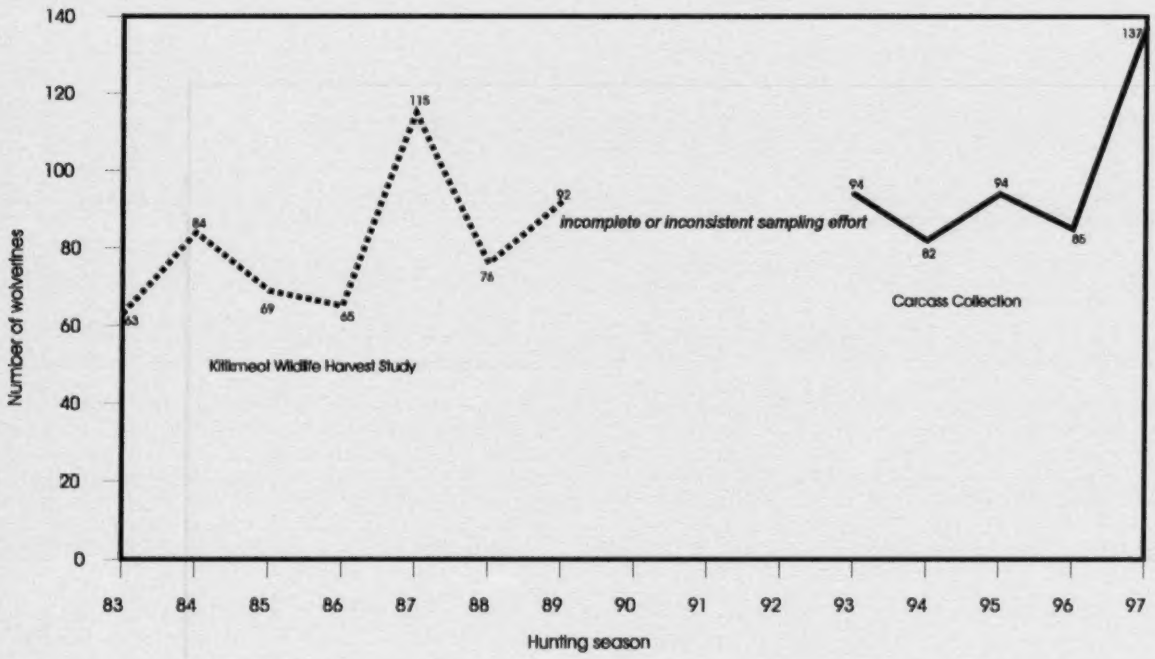

Figure 1. Estimated wolverine harvest from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1982/83 - 1996/97.

Locations

Harvest locations (Figure 2) stretched from Great Bear Lake, east past the Ellice River. Hunters and trappers in the Kitikmeot do not have registered or traditionally exclusive family trap lines or hunting areas. Harvesting occurred wherever people travelled. The bulk of the harvest from Kugluktuk took place south of the town and west of the Coppermine River. Umingmaktok and Bathurst Inlet hunters took most of their animals in the immediate Bathurst Inlet area. Wolverines taken by Cambridge Bay hunters were taken while travelling in the Bathurst Inlet area. Many of the wolverines killed in the Contwoyto and Pellatt Lake areas were taken by Kugluktuk residents working at Lupin Mine or living at the outpost camp on Pellet Lake.

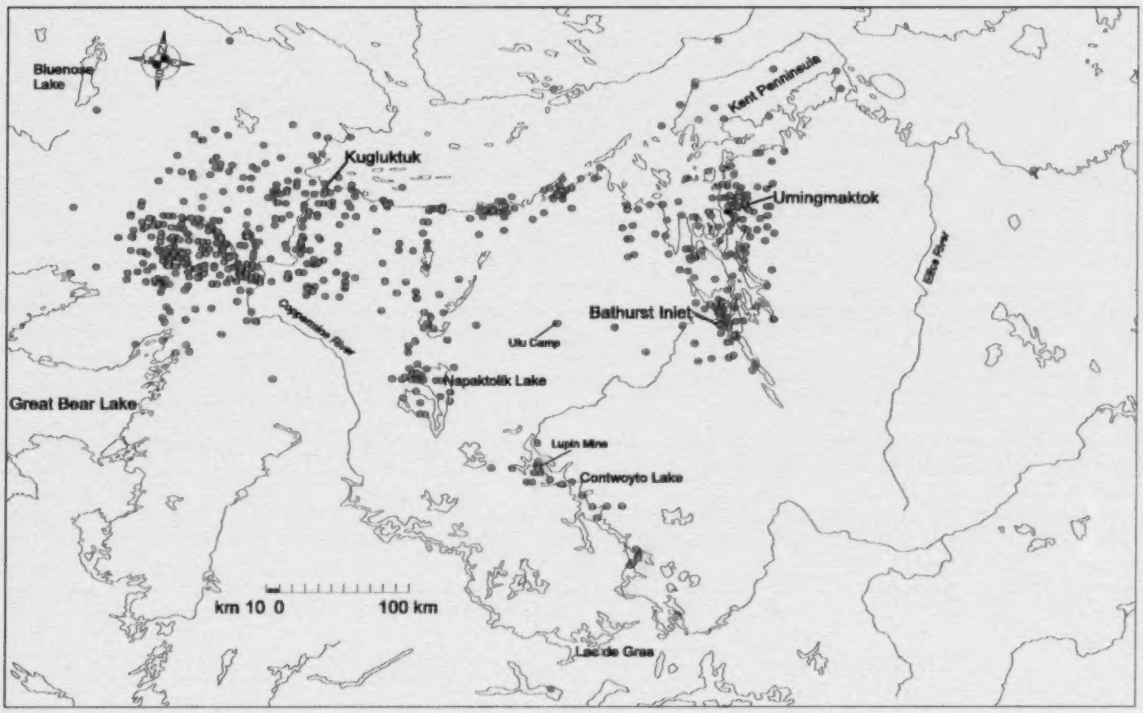

Figure 2. Locations where wolverines were harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97.

Sex and Age Composition

Overall sex and age composition

Ages of harvested wolverines ranged from <1 year to 11 years (Figure 3), the latter recorded for a female from the Bathurst Inlet area. The average age of males was 1.5 (n=437) and females, 1.7 (n=244). This reflects the larger number of young males harvested. The sex ratio was relatively consistent in favouring males by about twice (Table 7) throughout the years of the collection. The overall m:f sex ratio was 1.870. There was no significant difference in the age distribution of males and female in the harvest (Chi^2=2.148, p=0.342, df=2). Males accounted for approximately 61-68% of each age class (Table 8). The m:f sex ratio of the three age classes was: adults 1.763, yearlings 1.594, and juveniles 2.219.

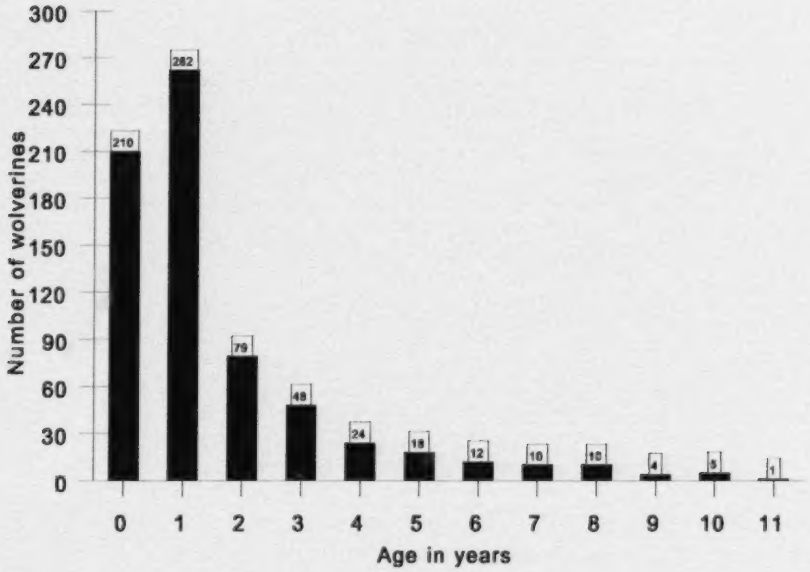

Figure 3. Age structure of wolverine harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86 - 1996/97.

Table 7. Sex composition of wolverines harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97.

	Harvest Season										
	86	87	88	89	90	92	93	94	95	96	97
Female	7	51	23	13	8	12	27	23	33	29	51
Male	26	51	42	32	20	35	54	56	60	56	86
Unkn	0	1	0	0	6	3	13	3	1	0	0
m:f sex ratio	3.714	1.000	1.826	2.462	2.500	2.917	2.000	2.435	1.818	1.931	1.686

Table 8. Sex and age of wolverines harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97. Numbers in parenthesis are percent of column. There was no collection in 1990/91 and the 1991/92 collection was not aged.

		Harvest Season									
	Age class	**1986**	**1987**	**1988**	**1989**	**1990**	**1993**	**1994**	**1995**	**1996**	**1997**
Female	Juvenile	3 (9.1)	7 (7.5)	3 (5.0)	2 (16.7)	2 (7.7)	5 (6.4)	9 (11.5)	8 (9.3)	8 (9.5)	20 (15.3)
	Yearling	1 (3.0)	18 (19.4)	11 (18.3)	1 (8.3)	2 (7.7)	8 (10.3)	12 (15.4)	19 (22.1)	13 (15.5)	16 (12.2)
	Adult	3 (9.1)	23 (24.6)	7 (11.7)	1 (8.3)	2 (7.7)	13 (16.7)	2 (2.6)	5 (5.8)	8 (9.5)	12 (9.2)
Male	Juvenile	13 (39.4)	14 (15.1)	4 (6.7)	2 (16.7)	6 (23.1)	18 (23.1)	17 (21.8)	13 (15.1)	25 (29.8)	30 (22.9)
	Yearling	0 (0.0)	13 (14.0)	17 (28.3)	5 (41.7)	11 (42.3)	25 (32.1)	22 (28.2)	27 (31.4)	16 (19.0)	25 (19.1)
	Adult	13 (39.4)	18 (19.4)	18 (30.0)	1 (8.3)	3 (11.5)	9 (11.5)	16 (20.5)	14 (16.3)	14 (16.7)	28 (21.3)
Total		**33**	**93**	**60**	**12**	**26**	**78**	**78**	**86**	**84**	**131**

Kill method and sex and age composition

Harvest method had a distinct and significant ($Chi^2=23.04$, df=1, $p<0.001$) effect on the sex composition of the harvest. The m:f sex ratio of hunted wolverines was 2.230 while the sex ratio for the trapped sample was 0.920. Approximately twice the numbers of males were shot, while trapping resulted in a sex ratio much closer to 1:1 (Figure 4).

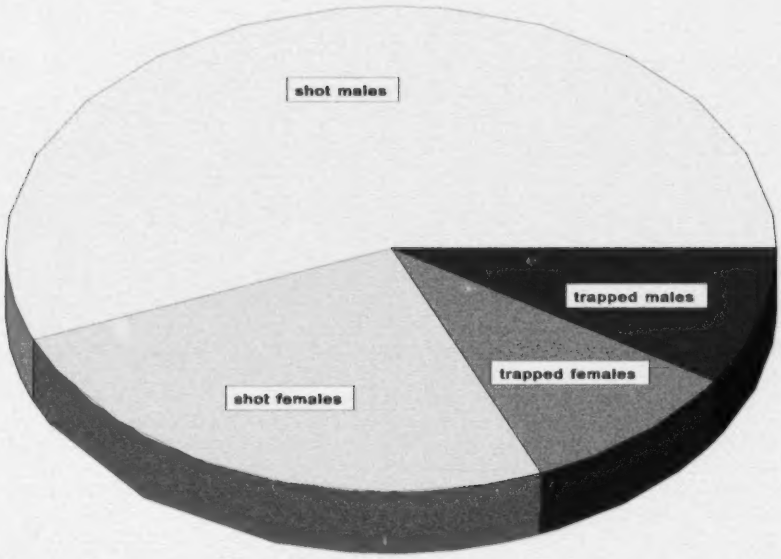

Figure 4. Sex distribution of hunted and trapped wolverines from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97.

Kill method appeared to have little effect on the age structure of the harvest. There was no significant difference between the age structure of the hunted and trapped sample (Chi^2=0.439, df=2, p=0.803). When broken into sex/age classes, age distributions of hunted males, hunted females, and trapped males did not differ from a 1:1:1 ratio. However, the trapped female age classes were not equally represented and the age distribution of A:Y:J was different from 1:1:1 (Chi^2=6.13, df=2, p=0.048). Yearling females appeared to be more vulnerable to trapping and dominated the female trapped sample (47%, n=64).

Season of year, sex and age composition

Wolverines were harvested from October through April (Figure 5) with December accounting for the most animals taken. When considering all age classes within the hunted sample, differences in the seasonal (fall, winter, and spring) sex distribution were not significant (Chi^2=3.835, df=2, p=0.148). However, there was a trend of increasing sex ratio of the hunted sample as the hunting season progressed (Table 9). Of all the females taken, the largest proportion (50%) was taken in winter. The trapped sample showed a consistent sex ratio close to 1.0 throughout the harvest season. The sample size of trapped wolverines was too small to examine by sex/age classes and season of the year.

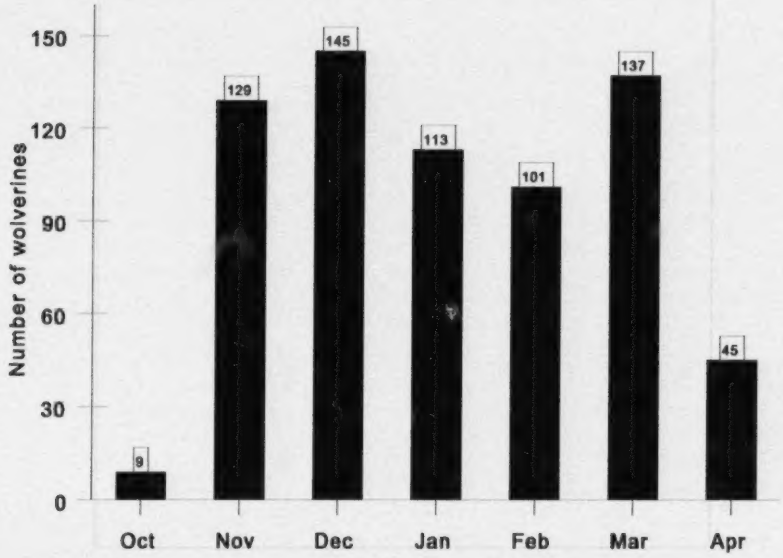

Figure 5. Months in which wolverines were harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet during the period 1985/86-1996/97.

Table 9. Sex distribution of wolverines harvested by hunting and trapping from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97.

	Female	Hunted male	Sex ratio	Female	Trapped male	Sex ratio
Fall	51	83	1.627	12	10	0.833
Winter	99	228	2.303	41	42	1.024
Spring	48	123	2.563	11	10	0.909

Among hunted animals, yearling wolverines occurred twice as frequently in the fall harvest as adults, and 1.5 times more than juveniles (Figure 6). The trend for yearling animals of both sexes was to begin as the higher proportion of the harvest in the fall and then decline toward spring. Yearling females dropped by over 50% from fall to spring. The proportion of juvenile and adult females in the harvest remained relatively constant throughout the harvest season and was lower than other age classes. The proportion of juvenile males increased slightly through winter to spring. Adult males increased in proportion steadily throughout the harvest season to almost twice its fall proportion. Distributions of sex/age classes among seasons were not significantly different from each other ($Chi^2>13.4$, $p=0.2$, $df=10$) but were different from 1:1:1:1:1:1 (AF:AM:YF:YM:JF:JM) ($Chi^2>14.0$, $p<0.02$, $df=5$).

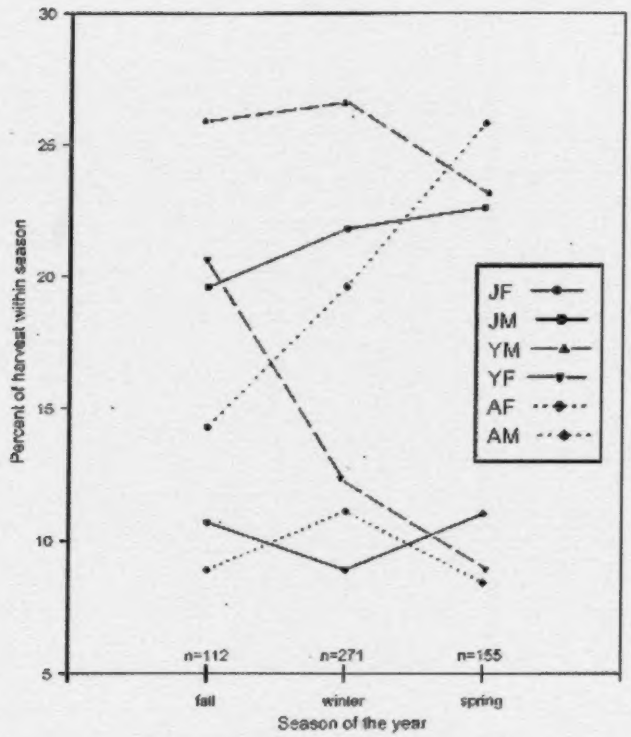

Figure 6. Age distribution of wolverines harvested by hunting as a proportion of the harvest by the season of the year. Each season sums to 100. JF=juvenile females, YF=yearling females, AF=adult females, etc.

Female Reproductive Characteristics

Counts of corpora lutea from females that were one year or older ranged from 0-5/female. No juvenile females were found with corpora lutea. The mean litter size of adult females with corpora lutea was 3.46 kits/litter and differed significantly (t=2.09, p=0.039, df=85) from the yearling litter size of 2.8 kits/litter (Table 10). Other than the jump in litter size from yearling to two year old (2.89-3.4 kits/litter) there was not a significant change (f=0.81, p=0.58, df=7,6) in litter size with increasing age for females with corpora lutea. Litter size varied from 3.2-4.0 kits/litter in animals older than one. Similarly, the percent pregnant was over 90% for all ages >1. The oldest female to have corpora lutea was 11 years old.

Table 10. Reproductive parameters of female wolverines harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet from 1985/86-1996/97.

	Mean litter size[1]	n	Max.	Min.	Percent pregnant[2]	Fecundity
Yearling	2.89 (2.8 n=5)*	28	5	1	35.4(n=82)	1.02
Adult	3.46 (3.47 n=15)*	59	5	1	91.3(n=69)	3.16

*Value in parentheses is mean litter size based on fetus count.
[1]Includes only females with corpora lutea or with foetuses.
[2]Pregnancy is based on presence of corpora lutea, fetuses, or implantation sites.

Twenty-two female wolverines were macro pregnant and had fetuses or detectable implantation sites. The sex ratio of fetal litters was 1.628 (M:F) (seven litters, 21 individuals). In paired samples, the mean litter size calculated from corpora lutea (4.06) and fetuses (3.38) were significantly different from each other (t=3.149, p=0.007, df=15). Fetuses were found in January (n=3), February (n=12) and March (n=7). Two of the three January fetuses were too small to measure as compared with two out of 19 from February and March. There was no correlation between harvest date and fetus size (Pearson's r=-0.1685). Fetuses ranged in size from 7-127 mm and 2.6-133gm. The two largest fetuses, 127 mm and 116 mm, occurred in early and late February, respectively. These fetuses appeared close to term. Mammary tissue was noted as present as early as February 18 and a post-partum uterus as early as March 9. Unmeasurable newly developing fetuses were found as early as January 3 and as late as the end of February. Based on a post-implantation gestation period of 30-40 days (Rausch and Pearson 1972), parturition in Kitikmeot wolverines would occur from mid-February to mid-April.

DISCUSSION

There is no requirement for wolverine pelts to be sealed, counted, or otherwise accounted for. The only mechanism for tracking the number of pelts is the DRR Fur Marketing System which misses those pelts that are used locally. In this context, it is not surprising that the fur harvest statistic underestimates the total harvest by over 50%.

The harvest estimated by the KWHS during 87 and 88, and the known minimum number based on same seasons where the carcass collection was the most complete, are reasonably close (Table 4). Because a small number of carcasses each season were not brought in, it is not unreasonable to assume that the wolverine harvest estimated by the KWHS may reflect the actual harvest in most years. The fact that the carcass collection continued to produce similar numbers to the KWHS in the years after the KWHS terminated, lends support to this. If the KWHS was representative, then based on the 87 and 88 seasons where the two methods overlapped, the carcass collection accounted for 87.6% of the harvest.

Although wolverine harvesting took place over a region approaching 100,000 km^2, it tended to be concentrated in three distinct areas: south and west of Kugluktuk, Napaktolik/Contwoyto Lake, and Bathurst Inlet (Figure 2). The surrounding unhunted areas may act as refugia or reservoirs that produce wolverines that move into the hunted areas and sustain the harvest. However, as the number of developments increase on the barrens and people from communities travel to them to work, areas that were not frequented before often begin to receive hunting attention. It may be very important that these unhunted areas are maintained and remain unhunted (McCullough 1996). If hunting moves into previously unhunted regions, breeding animals that could supply new animals for the harvest could be lost. Figure 2 gives the illusion that those areas without marks are not hunted. Although this may be the case, it is not a certainty. For example, hunters from Paulatuk whose wolverine harvest does not appear on the map may harvest the large unhunted area to the west toward Bluenose Lake.

The age distribution of the Kitikmeot wolverine harvest is weighted more toward yearling animals than harvests reported elsewhere. Thirty-eight percent of the Kitikmeot harvest (Figure 3) was composed of yearlings (62% males, 38% females), in contrast to 18 to 28% reported for Alaska, Yukon, and British Columbia (Banci 1987, Liskop et al.1981, Rausch and Pearson 1972). Young of the year made up the largest portion of those harvests.

The Kitikmeot harvest fits the general scenario common to many mustelid harvests where subadult animals are taken in greater proportion in the beginning of the season and adults become a larger proportion as the season progresses (Figure 6). Subadult wolverines are known to be the more transient age group and to make long distance movements during their dispersal (Gardner 1985, Magoun 1985, Mulders 1998 pers. comm.). Juveniles spend the first winter of their lives in general association with their maternal home range (Copeland 1996, Magoun 1985). Those juveniles that occur in the harvest between October and April are likely still associated with their natal area. Somewhere between the end of this first hunting season and the end of the next, the young wolverines become quite mobile and move away from their maternal area with young males tending to be more nomadic (Copeland 1996, Magoun 1985). This increased movement, and likely

accompanying nutritional stress, could lead to an increased vulnerability to human harvest as reflected in the Kitikmeot harvest numbers.

The proportions of all sex/age groups, except for adult males and yearling females, remained relatively constant throughout the harvest season. Adult males steadily increased over the harvest season and replaced yearling males as the dominant sex/age group by spring. Magoun (1985) suggests that because male home ranges are considerably larger than those of females and in shorter supply, males tend to remain transient longer and maintain their consequent harvest vulnerability. Some yearling females (35% in this study) breed during their second summer. Some of those would likely be denning with kits and exhibit more restricted movements. The substantial and steady decline of yearling females over the harvest season may be a reflection of a shift in their vulnerability as they begin to roam less.

Age and sex data from harvest samples cannot be counted on to directly reflect the composition of the population as whole. More probably, it is an indicator of varying harvest vulnerabilities of sex and age groups. Because of the different behaviours of each sex/age class, lumping either sex or age classes together may further mask trends. In addition, 81% of Kitikmeot wolverine hunting is by snow machine and comparison of harvest composition with areas where trapping is the major method, adds an even further complication.

The pregnancy rate of 91.3% for adult wolverines in the Kitikmeot harvest was generally high compared to similar studies. The Yukon (Banci and Harstad 1988) and British Columbia (Liskop et al. 1981) reported 73% and 77% respectively. Alaska, at 92%, was very close (Rausch and Pearson 1972) to Kitikmeot.

Female wolverines do not become sexually mature until sometime after one year of age and no juveniles in this study were found with corpora lutea[2]. Some females do breed in their second summer but their litter size and pregnancy rate can be quite variable (Hatler 1989) and lower than adult animals (Table 10). Unlike the Yukon (Banci and Harstad 1988), there was not an increase in the corpora lutea litter size with increasing age. Once Kitikmeot wolverines reached two years of age, the litter size based on corpora lutea counts had peaked. Similarly, the proportion of pregnant females rose dramatically from 35% for yearlings to 91% for two year olds. However, after that it levelled out. The fetal litter size in this study (3.5) was consistent with those reported elsewhere (Banci 1987, Rausch and Pearson 1972). Because of pre and post-natal mortality, actual litter sizes observed on the ground tend to be much smaller and range between 1.8 (Magoun 1985) and 2.5 (Pulliainen 1968).

Hatler (1989) suggests that the best relative measure of recruitment is likely to be the proportion of young animals in the harvest while a preponderance of adult females may suggest a need for management attention. What proportion of juveniles in the harvest would be acceptable, or what a preponderance of adult females would be is not clear. In Alaska approximately 30% of the harvest was adult females which is considerably higher than Kitikmeot. However in the same study, 42% of

[2]This would support the accuracy of cementum ageing for juveniles and yearlings.

the harvest was juveniles. In a sample of 126 wolverines harvested from Inuvik, only 4.8% were adult females and 45% were juveniles (Poole unpublished data). In Kitikmeot, the proportion of juveniles in the harvest has been somewhat steady (Table 11) and the proportion of adult females relatively low over the last five years.

A variation of monitoring the juvenile and the adult female proportions might be the ratio of adult females to juvenile animals. Or the percent of pregnant adult females (Table 11) may reflect the availability of potential mates. Considering the steady rise in the proportion of adult males in the harvest as the season progressed (Figure 6), an increased proportion of adult males early in the hunting season may indicate a scarcity of immigrating yearling animals. The interpretation of these indices is obscure at this time. However, the database on the wolverine harvest is just now approaching the point where the samples are high enough and the time span long enough that patterns may be forthcoming. The continuation of wolverine harvest data collection is recommended, as is a more meaningful probing of existing data collected to-date.

Table 11. Possible indices to harvest intensity of wolverines harvested by all methods and reported by hunters from Kugluktuk, Umingmaktok, and Bathurst Inlet during the period 1985/86-1996/97.

	1987	1988	1993	1994	1995	1996	1997
Percent pregnant females [1]	100	83.3	100	100	100	50	91.7
Percent juveniles	23.4	11.7	29.1	33.3	24.4	39.3	38.2
Percent adult females	14	11.7	16.7	2.6	5.8	9.5	9.2
Juveniles : adult females	0.957	1.0	1.769	13	4.2	4.1	4.2

[1] pregnancy is based on presence of corpora lutea, fetuses, or implantation sites

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